South Carolina

REASONABLY FORESEEABLE DEVELOPMENT SCENARIO FOR FLUID MINERALS

Prepared for:

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
EASTERN STATES
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The Bureau of Land Management is responsible for the stewardship of our public lands. It is committed to manage, protect, and improve these lands in a manner to serve the needs of the American people for all times. Management is based on the principles of multiple use and sustained yield of our nation's resources within a framework of environmental responsibility and scientific technology. These resources include air, fish and wildlife, minerals, paleontological relics, recreation, rangelands, scenic scientific and cultural values, timber; water, and wilderness.

BLM/ES/PL-08/XXX

TABLE OF CONTENTS

LIST OF FIGURES

ACRONYMS

ACEC	Area of Critical Environmental Concern
APD	Application for Permit to Drill
AU	Assessment Units
BCF	billion cubic feet
BLM	Bureau of Land Management
BOPD	barrels of oil per day
CBNG	Coal Bed Natural Gas
EIS	Environmental Impact Statement
EOR	Enhanced Oil Recovery
ESA	Endangered Species Act
EIS	Environmental Impact Statement
JFO	Jackson Field Office
MMBO	million barrels of oil
RFDS	Reasonable Foreseeable Development Scenario
ROD	Record of Decision
RMP	Resource Management Plan
SCDNR	South Carolina Department of Natural Resources
SCGS	South Carolina Geological Survey
SCMA	South Carolina Mining Association
SMA	Surface Management Agency
TCF	trillion cubic feet
TPS	Total Petroleum Systems
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	U.S. Geological Survey

Summary

1.0 INTRODUCTION

The Bureau of Land Management's Jackson Field Office is located in Jackson, Mississippi, and is responsible for 11 southern states: Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, and Virginia. The Jackson Field Office manages approximately 34.25 million acres of federal mineral estate in the eastern portion of the United State. Of this approximately 1.18 million mineral estate acres are located in South Carolina, however there is current no oil or gas production on federal minerals.

The Reasonable Foreseeable Development Scenario (RFDS) forecasts fluid mineral exploration, development, and production for the planning area for the next 10 years. The RFDS assumes a baseline scenario in which no new policies are introduced and all areas not currently closed to leasing and development are opened for oil and gas activity.

Interagency Reference Guide - Reasonably Foreseeable Development Scenarios and Cumulative Effects Analysis for Oil and Gas Activities on Federal Lands in the Greater Rocky Mountain Region" (USDI 2002), "Policy for Reasonably Foreseeable Development Scenario (RFD) for Oil and Gas (BLM WO IM No. 2004-089) and Planning for Fluid Minerals Supplemental Program Guidance (BLM Handbook H-1624-1) guided the criteria and analyses methods used in this RFD.

1.1 Discussion of Determining Oil and Gas Resource Potential

Potential accumulations of oil and gas are described in Section 2. Non-BLM land within the state may be included in this section when it provides a better understanding of resource potential on BLM property. These determinations were made using the geologic criteria provided by reference in Section 2. Also contained in Section 2 are descriptions of stratigraphy, structure, historic oil and gas activities, as well as relevant studies done in the area. Potential reservoir rocks, source rocks, and existing stratigraphic and structural traps are discussed in detail.

1.2 Methodology for Predicting Future Oil and Gas Exploration and Development Activity

Section 7 predicts the type and intensity of future oil and gas exploration and development activities. These forecasts are determined by an area's geology, and historical and present activity, as well as factors such as economics, technological advances, access to oil and gas areas, transportation, and access to processing facilities. Economics, technology, and other factors may be hard to predict because of their complex nature and rapid rate of change. Projections of oil and gas activities are based upon present knowledge. Future changes in global oil and gas markets, infrastructure and transportation, or technological advancements, may affect future oil and gas exploration and development activities within the state.

1.3 Relating the Potential for Resource Occurrence to Potential for Activity

Predicted oil and gas activity does not necessarily correlate with geologic potential for the presence of hydrocarbons. Although the geology of an area may suggest the possibility of oil and gas resources, actual exploration and development may be restricted by high exploration costs, low oil and gas prices, or difficulty accessing the area due to lease stipulations. Thus a small area may have a high resource potential, yet have a low exploration and development potential due to severe restrictions on access. Conversely, technological advancements or an increase in oil and gas prices could result in oil and gas activities in areas regarded as having low potential for occurrence.

2.0 DESCRIPTION OF THE GEOLOGY OF SOUTH CAROLINA

The state of South Carolina spans several distinct geologic regions, from northwest to southeast, those are the Blue Ridge, the Piedmont, and the Coastal Plain as shown in Figure 1. All of these geologic regions extend into the surrounding states and have varying potential for future oil and gas development. Figure 2 presents a generalized geological map of South Carolina.

2.1 The Blue Ridge

The Blue Ridge is a region of severely folded and faulted, low- to high-grade metamorphic rocks. Many of the rocks within the region appear to be metamorphosed Proterozoic or Paleozoic sedimentary rocks. Others are metamorphosed igneous rocks. This Blue Ridge is characterized by mountainous area of steep ridges, intermountain basins and valleys that intersect at angles, giving the area a rugged appearance. The steep slope that separates the mountains and Piedmont is the Blue Ridge escarpment. The Blue Ridge Region makes up only 2% of the land of South Carolina (SCDNR, 2008)

2.2 The Piedmont

In South Carolina the Piedmont region comprises one third of the area and is typically hilly country containing many monadnocks (resistant hills and knobs). Topographically, the difference between the hills and valleys are only a few hundred feet in elevation. Elevations range from 300 to 600 feet above sea level near its border with the Coastal Plain to 1,500 feet at the foot of the Blue Ridge. The Piedmont is underlain by metamorphic and igneous rocks of various origins that were folded during the Paleozoic as the North American and African plates converged. Later, in the Mesozoic, it was affected by rifting as Pangaea broke apart and the Atlantic Ocean formed.

2.2.1 The Fall Line

The Fall Line of South Carolina marks the contact of the Piedmont with the Atlantic Coastal Plain. The Fall Line is a boundary of bedrock geology between the metamorphics of the Blue Ridge and Piedmont with the largely unconsolidated sediments of the coastal plain, but it can also be recognized from stream geomorphology. Rivers crossing the Fall Line show falls or rapids and below the line they develop much broader flood plains.

2.3 The Coastal Plain

The Coastal Plain of South Carolina reaches from the beaches of the Coastal Zone to the Sandhills and the Fall line. This represents the largest geographic region in South Carolina covering approximately $^{2}/_{3}$ of the state and contains vast flood plains, marshland, swamps, savannahs, man-made lakes, and Carolina Bays.

The Coastal Plain can be divided into the lower, middle, and upper plain. The upper Coastal Plain sometimes called the Sandhills are hilly, unconnected bands of sand left from the ocean dunes during the Miocene Epoch. Above these sand deposits lies the Fall line, where the rocky river beds meet the sediment covered river bottoms of the Coastal Plain.

The middle costal plain is marked by the presence of numerous elliptical depressions called Carolina Bays. These bays are large, shallow oval-shaped indentions, which have long axes that are aligned in the same general direction, northwest to southwest. The bays range in size from a few acres to as many as thousands of acres. Most bays are found in the middle plain but some have been found in the upper and lower Coastal Plain as well. Bays can form bog swamps or stay dry and be savannahs for most of the year. A small number of bays have formed permanent lakes that have accumulated deep layers of organic soils. There are five many theories about how the Carolina Bays formed they are: the Meteorite Theory, the Tidal Eddy theory, the Artesian Spring

theory, the Underwater sea spring theory, and the prevailing wind theory (Debebe-Kumssa, et. Al. 2008)

The lower Coastal Plain is made–up of six steep slopes at the edge of high ground and seven terraces. The terraces represent the seven cycles of the receding oceans; two Pliocene, four Pleistocene, and one Holocene. Terraces represent the temporary ocean floors that rise and fall over time.

The sedimentary rocks of the Coastal Plain partly consist of sediment eroded from the Piedmont and Fall Line and partly of limestones generated by marine organisms and processes.

2.4 Subsurface Stratigraphy and Structure

The seismic refraction study of the Coastal Plain of South Carolina conducted by Bonin and Woollard in 1960 identified several gaps in existing well and geophysical data (Bonini & Woollard,1960). The following conclusions were derived from the study:

1) Basement lithologic trends and velocities are similar to those in the Piedmont therefore it is apparent that the Piedmont complex extends under the Coastal Plain sediments as far east as the present coast.

2) The Carolina Slate belt extends under the Coastal Plain and reaches a maximum width, of 80 miles in North Carolina, though the Triassic deep river basin is in the middle.

3) The buried Florence Triassic basin is an estimated 40 miles long on an east northeast strike and limited in width to 13 miles.

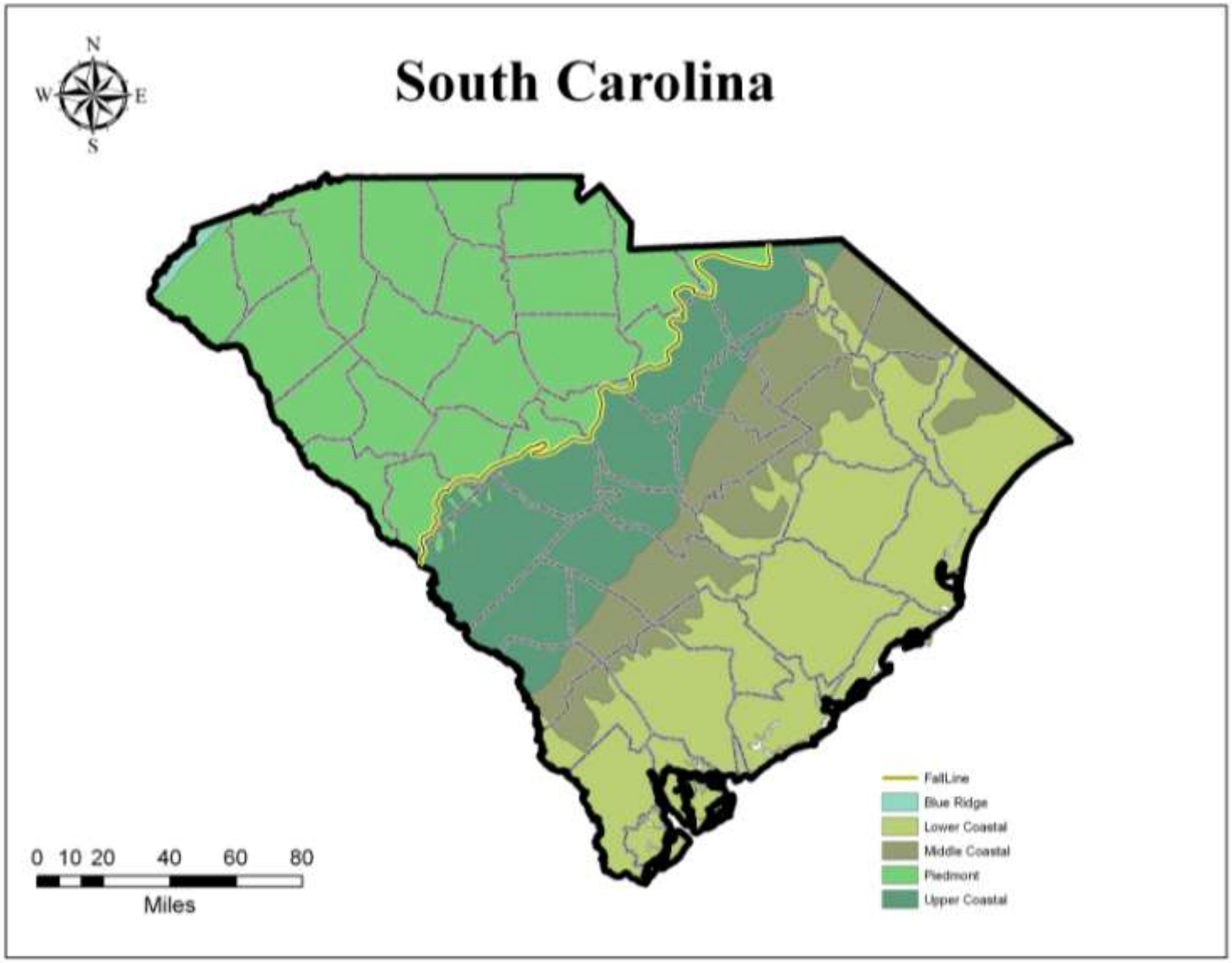
4) The Cape Fear arch is a prominent basement structure with a seaward slope of 13 ft. per mile on the axis. It is not reflected in the sea level basement surface contour near the Fall Line. Sedimentary record suggests differential movement at least twice since Cretaceous time.

5) The pre-Cretaceous basement is a surface of erosion with topographic relief on the order of 200 ft.

6) The break in basement slope in eastern North Carolina must be projected seaward of Cape Fear and the South Carolina coast.

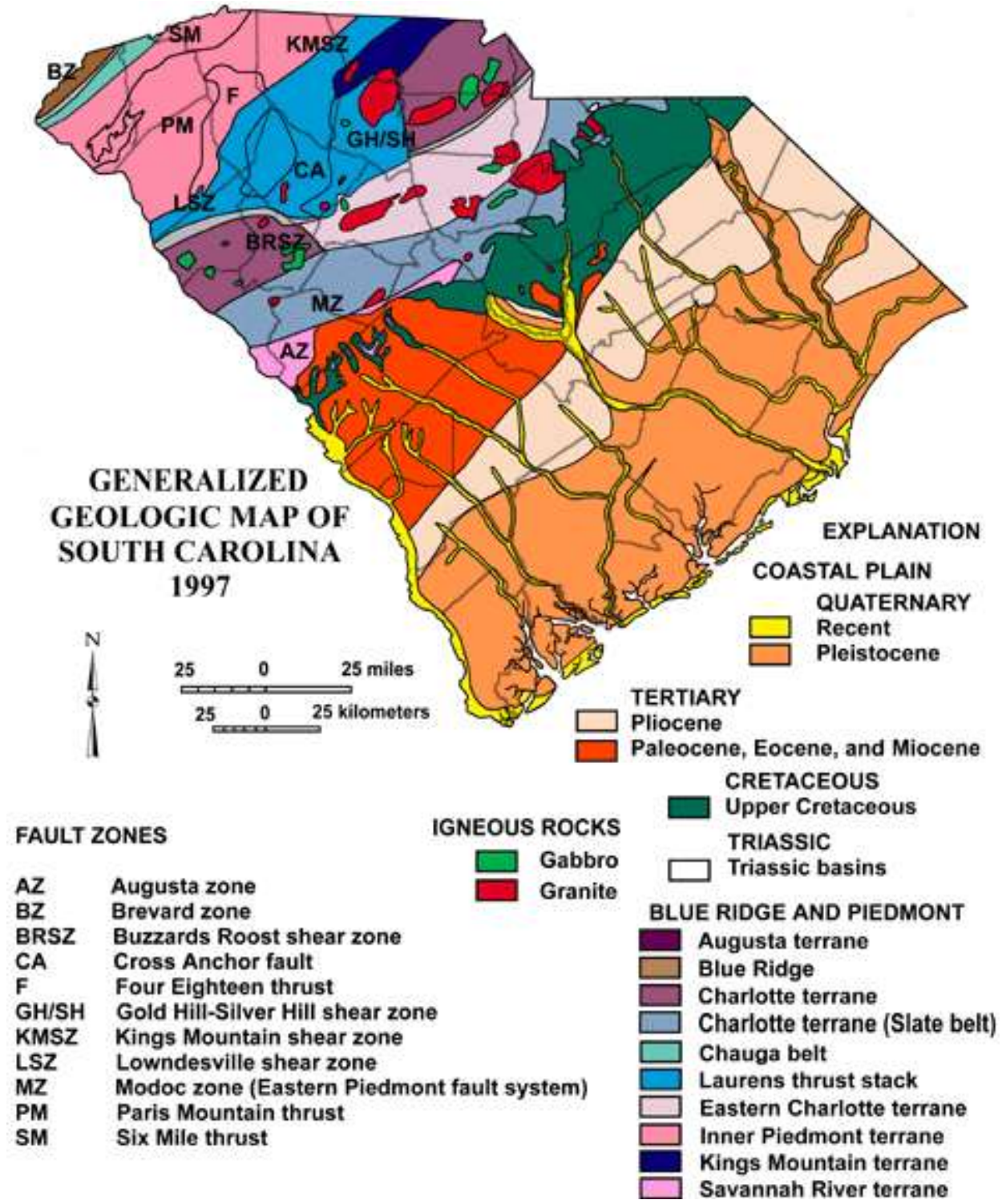
A generalized stratigraphic column of the Costal Plain is provided in Figure 3.

Figure 1: Geologic Regions of South Carolina



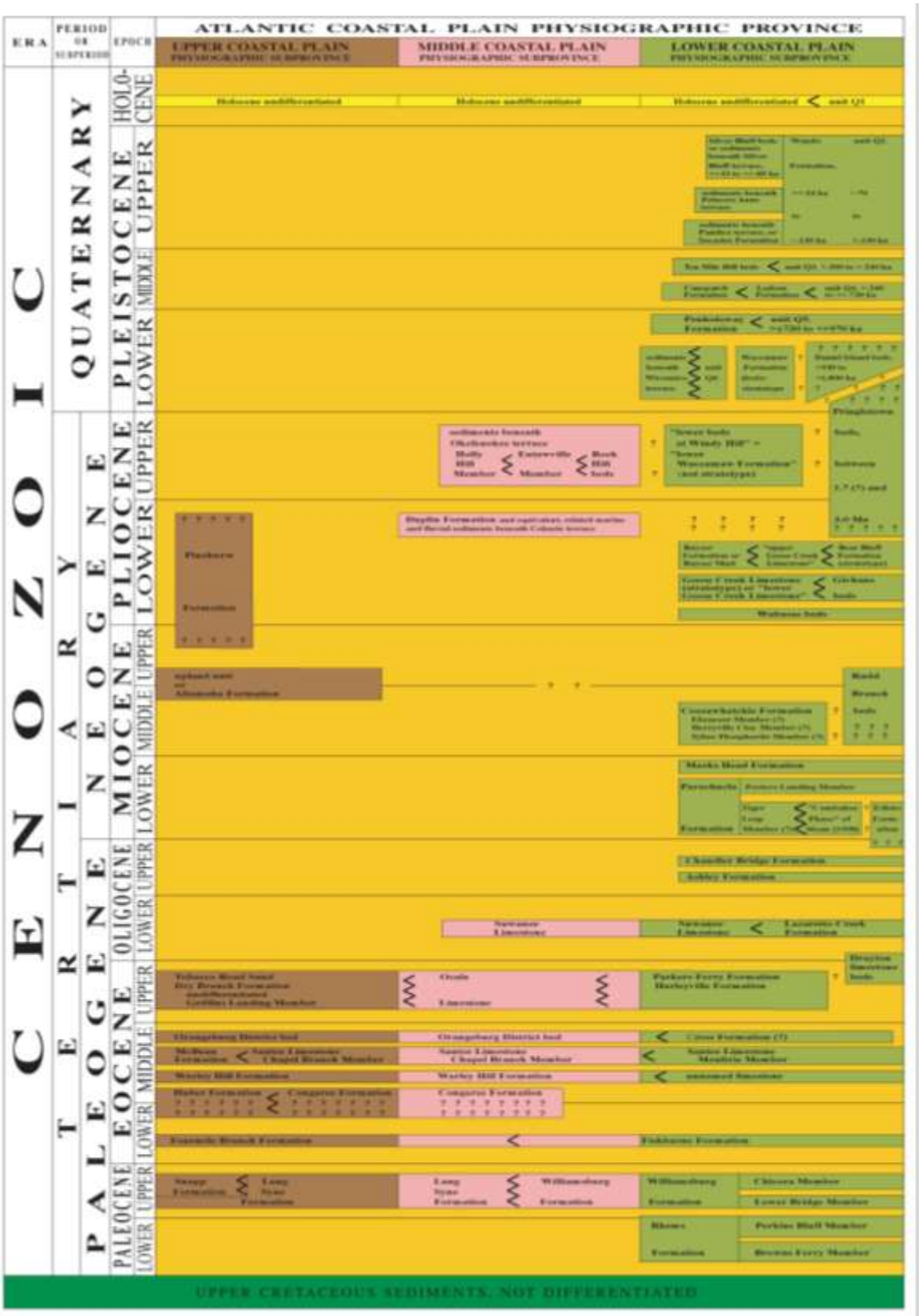
Source: South Carolina DNR - http://www.dnr.sc.gov/GIS/descgeolrl.html

Figure 2: Geological Map of South Carolina



Source: South Carolina Department of Natural Resources, Land, Water, and Conservation Division, Geological Survey

Figure 3: Generalized Stratigraphic Column for the Costal Plain of South Carolina



Source: South Carolina Geological Survey, 1999

3.0 SUMMARY OF USGS PLAY DESCRIPTIONS FOR THE STATE OF SOUTH CAROLINA

The most recent oil and gas assessments for the three geologic provinces that are within South Carolina were completed in 1995; The Blue Ridge Thrust Belt (068), piedmont (069) and the Atlantic Coastal Plain (070). In each of these province assessments a number of conventional and unconventional oil and gas plays were assessed however none indicate the presences of oil and gas in South Carolina.

The East Coast Mesozoic Basins also extend into parts of South Carolina however only hypothetical plays exist and no oil or gas has been found.

The primary source materials for this summary presentation are the geologic reports for each of the province assessments as published by the USGS and are available at the USGS National Oil and Gas Assessment website (http://energy.cr.usgs.gov/oilgas/noga/).

A copy of the USGS province report is available for review in Appendix A.

4.0 PAST AND PRESENT OIL AND GAS EXPLORATION ACTIVITY

4.1 Geophysical and Geochemical Surveys

Several areas in South Carolina are considered to have potential to produce oil and gas. The main area is the outer Coastal Plain. It contains a relatively thick pile of sedimentary rocks including some excellent reservoir rocks, but source rocks may not be present. Seismic surveys in the Blue Ridge suggest that sedimentary rocks may be present deep beneath the crystalline rocks. These may be similar to oil- and gas-bearing strata in the Valley and Ridge Province of Virginia and West Virginia. Detailed studies have not been conducted to verify the seismic surveys (Tayor, 2008).

4.2 Exploratory Drilling and Success Rates

Oil and Gas Exploration in South Carolina has occurred in two distinct periods. The first period occurred between 1920 and 1957 (Olson and Glowacz, 1977). During this time 11 wildcat wells were drilled in the Coastal Plain of South Carolina. All these wells were dry. The deepest well was the first well drilled in 1920 or 1921 near Summerville at 2,570 ft.

The second and current period of recorded activity began in 1980. These activities include leasing, soil geochemical analyses, seismic surveys, and drilling, and major companies and small independents have conducted them. Based on the SCDNR records five additional wells were drilled during this period. The latest was drilled in 2002 in Jasper County to a depth of 700 ft. The deepest well was drilled in 1984 in Colleton County to a depth of 12,700 ft. No additional information is available.

4.3 New Field and Reservoirs

The USGS recognizes no future oil and gas plays in the state (USGS, 1995). No new fields or reservoirs have been discovered.

5.0 OIL AND GAS ACTIVITY IN SOUTH CAROLINA

This section deals with the current status of oil and gas activity in South Carolina based on information provided by both public and private sources. Information includes; leasing activity, well spacing requirements, drilling permits by county, drilling practices, production statistics, oil and gas characteristics, oil and gas prices, operational costs (drilling and completion), conflicts with other mineral development, and gas storage fields.

5.1 Leasing Activity

It is possible that leasing occurred prior to 1980; but because there are no regulatory requirements for leasing in the State, no records of earlier activity are available.

There has been no leasing activity nor applications for permit to drill submitted in recent years (SCGS, 2008).

5.2 Regulations

The South Carolina Code of Regulations Chapter 121-8.0 *Oil and Gas Exploration, Drilling, and Production* is regulated by the Department of Natural Resources. The DNR has the jurisdiction to administer and enforce all aspects of the development of oil and gas in the state including permitting, spacing, completion and reporting.

5.3 Drilling and Completion Statistics

5.3.1 Drilling Practices

The majority of historic drilling operations in South Carolina have been standard vertical tests drilled with air rotary equipment that vary in depth from 200 feet to 12,000 feet with the average depth being 1250 ft. This range of is based on the Olson and Glowacz summary report and DNR well records (SCDHEC 2008).

5.3.2 Drilling and Completion Costs

Information regarding drilling costs and well completion costs was not available for the exploration wells drilled in South Carolina.

5.4 Production Statistics

5.4.1 Crude Oil

There has been no crude oil produced in South Carolina.

5.4.2 Natural Gas

There has been no natural gas produced in South Carolina.

5.5 Conflicts with Other Mineral Development

South Carolina has no major deposits of mineral fuels such as coal, natural gas, or petroleum. However, a variety of other minerals are produced. Cement, crushed stone, and gold are the state's leading mineral products. Clays and sand and gravel are among the other materials extracted. South Carolina generally ranks highly among the states in the production of kaolin, a type of white clay used in making pottery and paper. South Carolina also is the nation's leading producer of vermiculite, which is used for insulation and as a medium for planting. The state is the only gold producer east of the Mississippi River. Other minerals produced include peat, mica, silver, manganese, granite, and gemstones. Presently there are 13 minerals being extracted from 485 active mines in South Carolina. (MASC, 2008)

5.6 Gas Storage Fields

EIA gas storage data for 2006 indicates that there are no gas storage fields operating in the State of South Carolina (EIA website, Natural Gas Storage, Form EIA-191 Data, 2007).

6.0 OIL AND GAS OCCURRENCE POTENTIAL

Of the 16 wells that have been drilled for petroleum in South Carolina's Coastal Plain none have shown signs of petroleum-generating source rocks resulting in the apparent absence of oil and gas. All 16 wells were drilled in the Coastal Plain, none were drilled above the Fall Line, and none were drilled in the Mesozoic basins. Table 1 shows are the records the state has of oil and gas wells.

The USGS recognizes no future oil and gas plays in the state (USGS, 1995). Petroleum exploration nonetheless continues, if slowly, in the Coastal Plain. There are no active coal mines in the state and Coal Bed Methane is not expected to be prospective in the state.

Table 1: South Carolina Oil and Gas Well List

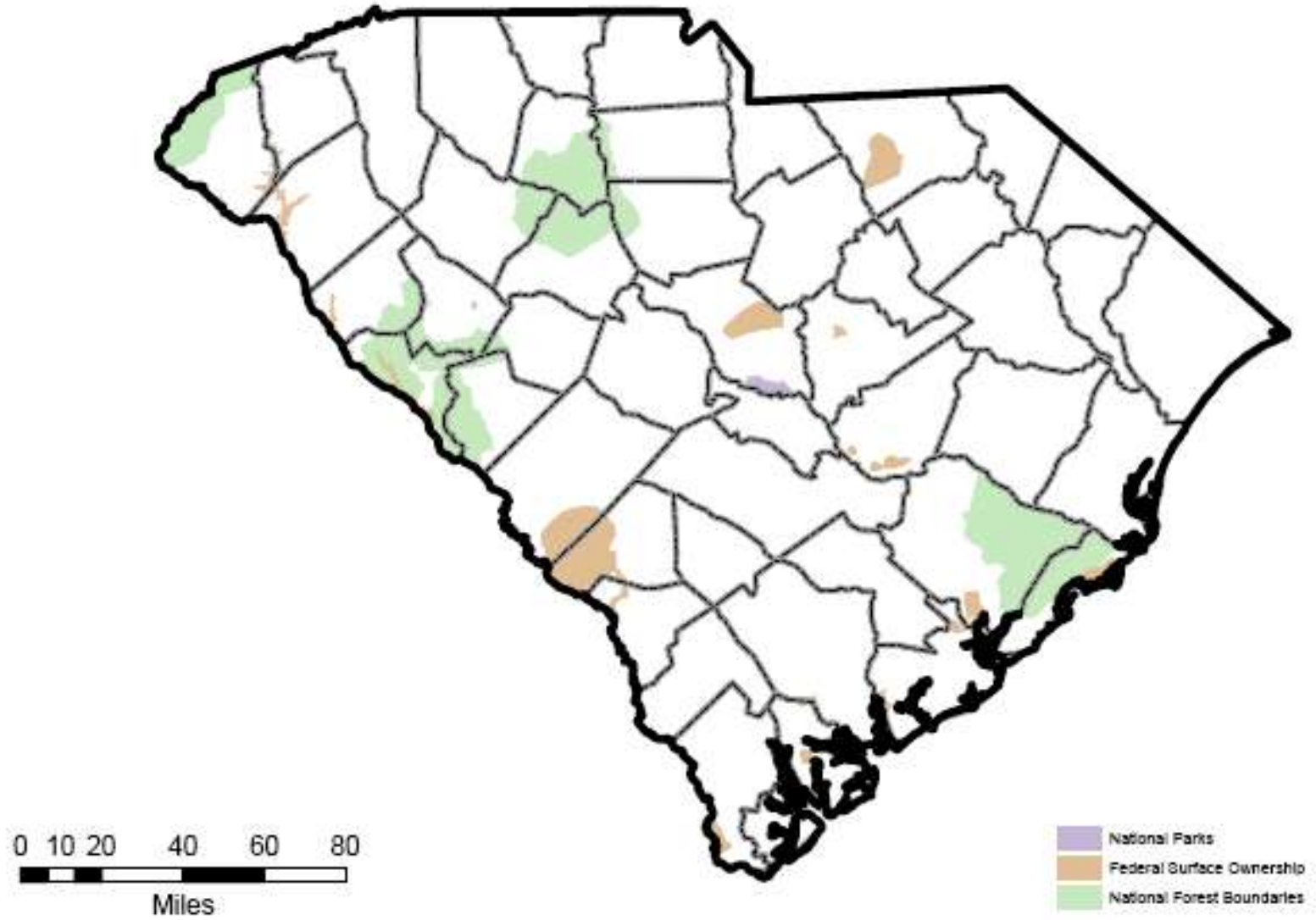
Well Name	Date Drilled	County	Depth	API Number
Summerville	1920-21	Dorchester	2,570	-
Allsbrooks Farm	1939	Horry	1,150	-
Tyler Farm	-	Horry	1,150	-
Smart Farm	-	Horry	1,429	-
Hucks 1	-	Horry	1,375	-
Lee Williams 1	-	Georgetown	1,397	-
Rhems	-	Williamsburg	825	-
Paris Island 1	1940	Beaufort	3,450	-
Paris Island 2	1940	Beaufort	3,450	-
Fannie Collins 1	1947	Horry	1,419	-
Allendale Test	1947	Allendale	200	-
Aiken Test 1	1950	Aiken	1,000	-
Aiken Test 2	1957	Aiken	492	-
Lightsey	1984	Colleton	12,700	3902920001
Dora Truluck	1986	Florence	5,889	3904120001
Marex McMillan	1988	Colleton	-	3902920002
Ram 1	2000	Jasper	709	-
Ram 2	2002	Jasper	700	-

Source: Olson and Glowacz, 1977 & SCDHEC, 2008

7.0 OIL AND GAS DEVELOPMENT POTENTIAL

No oil and gas wells are forecast to be drilled in South Carolina in the next ten years. This is consistent with the fact that the US Bureau of Land Management has never issued an oil and gas drilling permit for the State of South Carolina. Federal lands are distributed throughout the state as shown in Figure 4; these lands are dominated by National Forest Service holdings.

Figure 4: Federal Administered Lands in South Carolina



8.0 REASONABLE FORESEEABLE DEVELOPMENT BASELINE SCENARIO ASSUMPTIONS AND DISCUSSION

This RFD scenario assumes that all potentially productive areas are open under the standard lease terms and conditions except those areas designated as closed to leasing by law, regulation, or executive order. The areas closed to leasing typically include Areas of Critical Environmental Concern (ACECs), Wilderness Study Areas (WSAs) and USFWS Wildlife Refuges. The RFD scenario contains projections for the number or wells and acres disturbed for these counties. This in no way is intended to imply that the BLM are making decisions about the Forest Service lands or the USFWS lands. The predictions are intended to provide the information necessary so that all potential cumulative impacts can be analyzed. The disturbance for each well is based on the typical depth of wells for an area; generally, shallow gas wells disturb fewer acres than deeper oil wells. The assumptions for conventional oil and gas are as follows:

The number of wells was calculated based on historical statistics and data trends as follows:

- Wells drilled to date were taken from the South Carolina Department of Natural Resources, Information Circulars.
- The number of wells drilled to date was statistically analyzed to calculate a median per year wells drilled per county.
- The data trends associated with the last 6 years (2001-2006) represents a more accurate estimate of future development trends than historical data, thus, it is weighted more heavily.
- The data trends from 1979 to 1984 data set are a more accurate estimate of future trends than the complete historical record and were weighted more heavily than the historical record.
- The data trends for the complete historical record (1903 – 1979) represent the least accurate estimate of future development trends and, thus, it was weighted the lightest.
- For each geographic/geologic boundary region and sub region, the calculated estimates for future development were summed to obtain a per year well count.
- Wellhead oil and gas prices are a driving force for well drilling and completion; current prices are historically high and have resulted in increased activity throughout the state. An estimate of activity for the future well development to into consideration this influence. The forecast assumes wellhead oil and gas prices will remain high and development over the next 10 years will continue at an elevated rate.
- Estimates of well counts for the different mineral ownership entities are based on spatial analysis of the percent of mineral ownership within each county times the total number of producing wells anticipated to be developed in that boundary area.
- The average acreage figure (acres per well) for the resource area was used to estimate federal disturbed acres.
- The RFD projections have a 10-year life.
- The number of dry holes was determined based on historic analysis of dry holes in the geologic boundary areas.

The assumptions were used to calculate the number of wells to be drilled, the number of in-field compressors, and the number of sales compressors required.

9.0 SURFACE DISTURBANCE DUE TO OIL AND GAS ACTIVITY ON ALL LANDS

9.1 Surface Disturbances

There are no estimates of the surface disturbances associated with the development of oil and gas on federal minerals within the State of South Carolina because no new wells are predicted to occur over the next ten years.

10.0 REFERENCES

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Appendix A

USGS Play Descriptions